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(54) **Drug-containing sheath**

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates generally to the treatment of cardiovascular diseases such as restenosis, acute thrombosis, intimal hyperplasia and subacute thrombosis. More particularly, the invention relates to an expandable sheath containing a therapeutic drug for release into a body lumen for treating disease or injury.

Description of Related Art

[0002] Coronary devices have maintained unprecedented growth throughout the 1980's and 1990's such that coronary angioplasty is commonplace for treatment of atherosclerotic vascular disease. In a typical percutaneous transluminal coronary angioplasty (PTCA) procedure, a guiding catheter having a preformed distal tip is percutaneously introduced into the cardiovascular system through the brachial or femoral arteries and is advanced therein until the distal tip is in the ostium of the desired coronary artery. A guidewire and a dilatation catheter having an inflatable balloon on the distal end thereof are introduced through the guiding catheter with the guidewire slidably disposed within an inner lumen of the dilatation catheter. The guidewire is first advanced out of the distal end of the guiding catheter and is maneuvered into the patient's coronary vasculature containing the lesion to be dilated, and is then advanced beyond the lesion. Thereafter, the dilatation catheter is advanced over the guidewire until the dilatation balloon is located across the lesion. Once in position across the lesion, the balloon of the dilatation catheter is filled with radiopaque liquid at a relatively high pressure (e.g., greater than about four atmospheres) and is inflated to a predetermined size to radially compress the atherosclerotic plaque of the lesion against the inside of the arterial wall to thereby dilate the lumen of the artery. The balloon is then deflated so that the dilatation catheter can be removed and blood flow resumed through the dilated artery.

[0003] By way of example, further details of the angioplasty procedure and the devices used in such procedures can be found in U.S. Patent 4,323,071 (Simpson-Robert); U.S. Patent No. 4,439,185 (Lindquist); U.S. Patent No. 4,516,972 (Samson); U.S. Patent No. 4,538,622 (Samson et al.); U.S. Patent No. 4,554,929 (Samson et al.); U.S. Patent No. 4,616,652 (Simpson); U.S. Patent No. 4,638,805 (Powell); and U.S. Patent No. 4,748,982 (Horzewski et al.).

[0004] A common problem that sometimes occurs after an angioplasty procedure is the appearance of restenosis at or near the site of the original stenosis in the blood vessel which requires a secondary angioplasty procedure or a bypass surgery. Numerous approaches were developed during the late 1980's to treat restenosis of the coronary arteries in an attempt to decrease the incidence of acute complications and the chronic restenosis rate. For example, in the prior art are mechanical approaches such as atherectomy, stents, laser angioplasty, and the application of pharmacologic agents. Of the mechanical approaches described, stets have been the most promising to prevent restenosis and to prevent elastic recoil of the vascular wall.

[0005] In expandable stents that are delivered with expandable catheters, such as balloon catheters, the stents are positioned over the balloon portion of the catheter and are expanded from a reduced diameter to an enlarged diameter, greater than or equal to the diameter of the arterial wall, by inflating the balloon from within the stent. Stents of this type can be expanded to an enlarged diameter by deforming the stent and expanding it into engagement with the vascular wall. It is common for stents of this type to experience endothelial growth over and around the stent. Examples of such expandable catheters and stents are disclosed in U.S. Patent No. 5,102,417 (Palmaz), U.S. Patent No. 5,123,917 (Lee), and U.S. Patent No. 5,133,732 (Wiktor).

[0006] Unfortunately, the stents that are currently being implanted are reported to have a fairly high restenosis rate, in the seven to forty percent range. With this relatively high restenosis rate, there has developed a need for some means of reducing the restenosis rate when using a stent, and limiting recurrent stenosis even when a stent is not used.

[0007] Further expandable stets are shown in EP-A-0,604,022, DE-A-3,640,745, EP-A-0,621,017 and EP-A-0,649,637. In particular, EP-A-0,604,022 describes a stent of multilayered laminated construction wherein one layer addresses the structural requirements of the stent and additional layers release drugs at predictable rates. Both the structural layer as well as the drug releasing layers are eventually completely resorbed by the body. DE-A-3,640,745 shows a double-walled endoprosthesis which contains an adhesive in the space between the two walls. It is received on a catheter and can be inserted together with the latter, for example into a vessel, in the correct position and can be implanted in this vessel by radial widening and subsequent fixing in the widened position. EP-A-0,621,017 describes an intravascular stent comprising a cylindrical sheet having overlapping edges that interlock. The edges have a series of protrusions and apertures that interlock and ratchet as the stent expands to an open position to support-a section of arterial wall. The stent may be expanded by a balloon catheter or it may be self-expanding. The stent is biocompatible, may be bio-erodible, and capable of localized drug delivery. EP-A-0,649,637 describes an at least partially preformed polymeric product for paving or sealing the interior surface of a tissue lumen by entering the interior of the tissue lumen and applying said polymer to the interior surface of the tissue lumen. The polymer can be delivered to the

lumen as a monomer or prepolymer solution, or as an at least partially preformed layer.

SUMMARY OF THE INVENTION

[0008] According to the present invention there is provided an expandable sheath for delivering a therapeutic drug in a body lumen, comprising an expandable membrane in the form of a cylindrical member and having a first end and a second end, and a first layer and a second layer, said first layer and said second layer being affixed to each other along their edges to form a drug-containing reservoir between the two layers, said first layer having a plurality of apertures through which a therapeutic drug can diffuse from within said drug-containing reservoir, said plurality of apertures remaining open when said first layer is in a stretched condition and said apertures tightly closing when said first layer is in a relaxed condition; a therapeutic drug contained within said reservoir; and means for intraluminally delivering and expanding said expandable membrane in the body lumen so that said therapeutic drug can be eluted at a specific site in the body lumen.

[0009] One of the primary advantages of these embodiments is to provide local delivery of a therapeutic drug to eliminate the need for systemic delivery which may have undesirable side effects. Local delivery of a drug can be accomplished using a drug loaded expandable membrane carried by a perfusion-type catheter system (non-implantable) or by loading the membrane on a stent for implanting in a vessel. The drug release from the expandable membrane can be controlled to match a particular clinical need or specific condition such as restenosis or acute thrombosis.

[0010] The expandable sheath of a preferred embodiment comprises an expandable membrane in the form of a tubular or cylindrical member having a cavity for carrying a drug. The membrane may in addition carry a therapeutic drug in the form of a matrix. A therapeutic drug is loaded in the expandable membrane so that it can diffuse outwardly into the vessel wall once the expandable membrane is delivered to the site where a PTCA procedure has occurred. The expandable membrane is mounted on the distal end of a catheter, and more specifically on an expandable portion (balloon) by sliding or stretching the expandable membrane around the expandable portion of the catheter.

[0011] In one embodiment, the membrane may be in the form of a flat sheet with a first and second edge which overlap and are attached to each other so as to form a sleeve around the expandable portion of the catheter. In an alternative embodiment, the membrane is in the form of a seamless tube carried by the catheter. The catheter is then delivered intraluminally to the area where the diseased or injured area has occurred and the expandable portion of the catheter is expanded such that it also expands the expandable membrane. Once expanded, the therapeutic drug diffuses into the vessel wall for treating the injured or diseased area. Thereafter, the expandable portion of the catheter is deflated and the catheter and expandable membrane are withdrawn from the vasculature.

[0012] Prior to attaching the two layers of the expandable membrane, the first elastic layer is stretched and drilled with a plurality of micro-holes or apertures through which the therapeutic drug can pass. Thereafter, the first layer and second layer are affixed to each other as described, and a therapeutic drug is injected into the cavity between the two layers through any of the plurality of apertures. When the expandable membrane is in its relaxed condition, the plurality of apertures close tightly so that no therapeutic drug can pass therethrough. The expandable membrane is then rolled onto the balloon portion of the catheter to form a cylindrical configuration and is delivered intraluminally as described above. The flat sheet is rolled into a cylinder and the edges are joined by welding, adhesive, etc. The balloon portion of the catheter is expanded thereby expanding the expandable membrane and forcing the therapeutic drug through the plurality of apertures and into contact with the vessel wall at the site of the injured or diseased area. After the therapeutic drug has been delivered, the balloon portion of the catheter is deflated and the catheter and expandable membrane are withdrawn from the vasculature. Instead of forming the expandable membrane from flat sheets, this embodiment may also be achieved with two tubular members, one within the other, to form a cavity between the layers. The ends are sealed and laser micro-holes are drilled into the outer layer to allow the therapeutic drug to pass therethrough. The tubular members also may have a drug incorporated in the polymer material in the form of a matrix which allows the drug to diffuse into the vessel wall over time.

[0013] In yet another embodiment of the invention, an intravascular stent is mounted on the balloon portion of a catheter so that it may be implanted in a conventional manner within the vasculature. An expandable membrane having a therapeutic drug contained therein, in the form of a matrix, is mounted on the outer surface of the stent and the catheter, stent, and expandable membrane are delivered intraluminally to the injured or diseased area. As the balloon is expanded, it forces the stent radially outwardly along with the expandable membrane and into contact with the vessel wall. The balloon portion of the catheter is then deflated and the catheter and balloon withdrawn from the vasculature leaving the intravascular stent and expandable membrane implanted at the injured or diseased area. Thereafter, the therapeutic drug will diffuse from the matrix into the vessel wall to provide treatment in an effort to reduce the incidence of restenosis.

[0014] The expandable membrane may be deployed in a body lumen through a variety of devices, including, but not limited to, balloon catheters and specialized devices which can deliver a stent within a body lumen.

These and other advantages of the invention will become more apparent from the following detailed description thereof when taken in conjunction with the accompanying exemplary drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIGURE 1 is a top view of an expandable membrane prior to rolling into a cylindrical configuration;

FIG. 2A is a perspective view of the expandable membrane of FIG. 1 in its rolled up condition with its first edge attached to the second edge in an overlapping relationship;

FIG. 2B is a perspective view depicting the elastic membrane in a hollow tubular form that is seamless;

FIG. 3 depicts a partial cross-sectional view of an elevation of a rapid exchange catheter system having a stent mounted on a balloon with the expandable membrane mounted over the stent;

FIG. 4A is a partial cross-sectional view depicting an over-the-wire catheter system having a stent mounted on the balloon portion of the catheter and an expandable membrane mounted over the stent;

FIG. 4B is a partial cross-sectional view of a perfusion-type catheter system having a stent mounted on the balloon portion of the catheter and an expandable membrane over the stent;

FIG. 5 is an elevational view depicting the rapid exchange catheter system of FIG. 3 wherein the stent mounted on the balloon portion of the catheter has a specific configuration and the expandable membrane is mounted over the stent;

FIG. 5A is a cross-sectional view taken along line 5A-5A depicting the expandable membrane over the stent and balloon portion of the catheter;

FIG. 6 is a partial cross-sectional view of the catheter delivery system and stent with the membrane mounted on the stent being transluminally delivered within the patient's vasculature;

FIG. 7 is a partial cross-sectional view of the balloon portion of the catheter expanding the stent and the expandable membrane within the patient's vasculature;

FIG. 8 is a partial cross-sectional view of an intravascular stent and an expandable membrane implanted against the patient's vessel wall;

FIG. 8A is a cross-sectional view taken along line 8A-8A depicting the expandable membrane and stent expanded and in contact with the vessel wall;

FIG. 9 is a perspective view of the expandable membrane of the present invention wherein the first layer and the second layer are spaced apart prior to affixing the edges to each other;

FIG. 10 is the expandable membrane of FIG. 9 wherein the first layer and the second layer have been joined and the plurality of holes are closed since the membrane is in its relaxed condition;

FIG. 11 is a perspective view of the expandable membrane of FIG. 10 in its rolled up condition and in an unexpanded state with the plurality of microholes tightly closed thereby containing the drug within the drug filled reservoir;

FIG. 11A is a perspective view of an expandable membrane having an inner tube and an outer tube with a drug receiving cavity in between the two tubes;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] During PTCA procedures it is common to use a dilatation catheter to expand a diseased area to open the patient's lumen so that blood freely flows. Despite the beneficial aspects of PTCA procedures and its widespread and accepted use, it has several drawbacks, including restenosis and possibly acute thrombosis. This recurrent stenosis has beer. estimated to occur in seventeen to fifty percent of patients despite the initial PTCA procedure being successful. Restenosis is a complex and not fully understood biological response to injury of a vessel which results in chronic hyperplasia of the neointima. Intimal hyperplasia is activated by growth factors which are released in response to injury. Acute thrombosis is also a result of vascular injury and requires systemic antithrombotic drugs and possibly thrombolytics as well. This therapy can increase bleeding complications at the catheter insertion site and may result in a longer hospital stay. Another result of vessel injury is acute closure. It occurs in 3-5% of patents receiving a PTCA procedure and is caused by any one or all of three events, namely, thrombosis, vessel dissection, and/or elastic recoil.

[0017] Several procedures have developed to combat restenosis and acute closure, one of which is the delivery and implanting of an intravascular stent. Stents are in their developmental stage at this point and are being used in clinical trials throughout the United States and are regularly implanted in patients in Europe and other countries. Generally speaking, the stents can take numerous forms, however, it is generally a cylindrical hol-

low tube that holds open the vascular wall at the area that has been dilated by the dilatation catheter. The use of a stent does not always reduce restenosis and can aggravate the situation causing acute thrombosis, subacute thrombosis and intimal hyperplasia. In order to address the complications arising from PTCA procedures and the deployment of intravascular stents, the present system for delivering therapeutic drugs was developed.

[0018] Figures 1, 2A and 2B provide background information for the incorporation of a therapeutic agent within the elastic membrane of the present invention.

[0019] In FIGS. 1 and 2A, an elastic membrane 5 is depicted wherein it has a first edge 6 and a second edge 7. In FIG. 2A, elastic membrane 5 has been rolled into a cylindrical form with first edge 6 and second edge 7 attached in an overlapping relationship as depicted at point 8. It may be desirable to join first edge 6 and second edge 7 in an abutting relationship (not shown) rather than overlapping in order to reduce the overall profile. FIG. 2B, depicts an elastic membrane 5 wherein it has a first end 1 and a second end 2 and is a substantially hollow cylinder. It further has an inner surface 3 and an outer surface 4 and is generally of a unitary nature. That is, it is formed from a continuous material and has no seams or overlapping edges. Various means are described below in which a therapeutic agent is incorporated within elastic membrane so that it may be delivered into a patient's vascular system for the purpose of diffusing the therapeutic agent at a controlled rate.

[0020] Expandable membrane 5 may be formed of any suitable material that is elastic and resilient. The material preferably is one that has a high degree of non-linearity (plastically deformable) for a wide range of stress and strain values (i.e., very low residual stress). In the preferred embodiment, however, any elastic material my be used. commercially available tubing such as "C-Flex" tubing may be used. C-Flex may be obtained from Concept Polymer Technologies of Largo, Florida. In addition, the expandable material should have good tear strength to prevent fracturing or splitting when it is expanded and stretched. Other suitable properties for expandable membrane 5 include low modulus of elasticity, high toughness, a high percentage of elongation (at least 300%), and minimal residual stress after expansion. Several preferred materials for expandable membrane 5 are ethylene vinyl acetate (EVA) and biospan. Other suitable materials for expandable membrane 5 also include latexes, urethanes, polysiloxanes, and modified styrene-ethylene/butylene-styrene block copolymers (SEBS) and their associated families as well as elastomeric bioabsorbable materials from the linear aliphatic polyester group.

[0021] A therapeutic drug may be combined with the expandable membrane 5 for the purposes of diffusing the drug into the vessel wall of the patient. For this purpose any therapeutic drug for use in the body can be combined with the expandable membrane for treatment purposes. For example, therapeutic drugs for treating an injured or diseased area in a vessel and for combination with the expandable membrane can include antiplatelets, antithrombins, and antiproliferatives. Examples of antiplatelets and antithrombins include sodium heparin, LMW heparin, hirudin, hirulog, argatroban, forskolin, vapiprost, prostacyclin, dextran, D-phe-pro-arg-chloromethylketone (synthetic antithrombin), dipyridamole, glycoprotein IIb/IIIa platelet membrane receptor antibody, recombinant hirudin, thrombin inhibitor (from Biogen) and 7E-3B (antiplatelet drug from Centocor). Examples of antiproliferatives include angiopeptin (somatostatin analogue from a French company: Ibsen), angiotensin converting enzyme inhibitors (Captopril (Squibb), Cilazapril (Hoffman-LaRoche) and Lisinopril (Merk)), calcium channel blockers (Nifedipine), colchicine, fibroblast growth factor (FGF) antagonists, fish oil (omega 3-fatty acid), low molecular weight heparin (Wyeth, Glycomed), histamine antagonists, lovastatin (inhibitor of HMG-CoA reductase, cholesterol lowering drug from Merk), methotrexate, monoclonal antibodies (to PDGF receptors, etc.), nitroprusside, phosphodiesterase inhibitors, prostacyclin analogues, prostaglandin inhibitor (Glaxo), seramin (PDGF antagonist), serotonin blockers, steroids, thioprotease inhibitors, triazolopyrimidine (PDGF antagonist from Japanese company). while the foregoing therapeutic agents have been used to prevent or treat restenosis and thrombosis, they are provided by way of example and not meant to be limiting, as other therapeutic drugs may be developed which are equally applicable for use with the present invention.

[0022] The therapeutic drug is combined with expandable membrane 5 by one of several methods. The therapeutic drug can be loaded into the expandable membrane by known methods such as melt processing, solvent casting, injection molding, extrusion, coating or by diffusion/ absorption techniques. Other methods of incorporating a drug into a polymeric material are well known and include heating processes. Such processes must be carefully monitored and controlled at temperatures that are low enough to prevent degrading the drug. It is important that the therapeutic drug be able to diffuse out of expandable membrane 5 and into the patient's vascular system at a controlled rate once the expandable membrane is delivered to the injured or diseased area. Thus, the rate of diffusion is controlled to fit the circumstances and can range from a very rapid diffusion to a long term diffusion rate.

[0023] Generally speaking expandable membrane 5 can be delivered within a patient's vascular system by any catheter system such as commonly and well known dilatation catheters having balloon portions at their distal tips. There are a wide range of catheter systems available, three of which are depicted in FIGS. 3, 4A and 4B. In FIG. 3 a rapid exchange catheter system is depicted, in FIG. 4A an over-the-wire system is depicted and in FIG. 4B a perfusion catheter is depicted. For purposes of the present invention, however, any of these systems

suffice and numerous other catheter systems would be appropriate, including dilatation catheters. Typical dilatation catheter and perfusion balloon catheter systems can be found in U.S. Patent Nos. 4,323,071; 4,516,972; 5,061,273; 5,137,513; 5,195,971.

[0024] An advantage to using a perfusion balloon catheter system is that the balloon can remain inflated for longer periods of time since it allows blood flow to continue past the inflated balloon.

[0025] While expandable membrane 5 can be mounted directly to the balloon portion of a catheter for intraluminal delivery, the preferred embodiment is to deploy expandable membrane 5 in the patient's vascular system using an intravascular stent. Thus, FIGS. 4A, 4B, 5 and 5A illustrate a stent delivery system which embodies features of the invention for implanting expandable membrane 5.

[0026] Referring to FIG. 3, the rapid exchange delivery system includes a delivery sheath 10 which has an outer lumen 11 and an intravascular catheter 12 disposed within the outer lumen 11. The intravascular catheter has an elongated catheter body 13 and a balloon 14 on the distal portion of the catheter body. A manipulating device 15 is provided on the proximal end of the delivery system which is employed to affect relative axial or longitudinal movement between the delivery sheath 10 and the intravascular catheter 12. An expandable stent 16, which is to be delivered and implanted within a patient's body lumen, is mounted on the exterior of the balloon 14. The stent disclosed in US-A-5 421 955 which is commonly assigned, is suitable for use with the present invention. Such stents are expandable and deform beyond their elastic limit to hold open the vessel wall in which they are implanted.

[0027] The delivery sheath 10 has a distal port 17 in its distal end which is in fluid communication with the outer lumen 11 and a proximal port 18 disposed proximally to the distal port. The distal portion of delivery sheath 10 tapers down in a spherical-like manner so that the cross-sectional area is somewhat less in the distal region than the cross-sectional area of the rest of the delivery sheath. A slit 19 extends from the proximal port 18 to a location just proximal of the distal port 17.

[0028] The intravascular catheter 12 has a distal port 20 and a proximal port 21 which are in fluid communication with a first inner lumen 22 extending within the distal portion of the catheter 12 and which is adapted to slidably receive a guidewire therein. A slit 23 extends from the proximal port 21 to a location 24 proximal of the proximal end of balloon 14. The proximal end of the guidewire receiving first inner lumen 22 is provided with a ramp 25 to guide the proximal end of guidewire 26 out of the proximal port 21 of intravascular catheter 12 when the catheter is mounted onto the guidewire, as will be discussed hereinafter. A second, much longer inner lumen 27 is provided within the catheter body 13 to direct inflation fluid from the proximal end of the catheter body to the interior of balloon 14.

[0029] Proximal of the proximal port 21 in catheter body 13 is a stiffening member 28 which is disposed in a third inner lumen 29 provided within catheter body 13. As shown in the drawings, third inner lumen 29 and first inner lumen 22 may be the same lumen with a plug 30 separating the two lumens. The ramp 25 is on the distal side of plug 30.

[0030] In a typical stent deployment, expandable membrane 5 is loaded onto stent 16 so that it covers the stent without overlapping the ends of the stent. The expandable membrane and intravascular stent will be implanted in a patient's vascular system to treat the diseased and injured area and to allow sufficient blood flow through the vessel. Thus, as depicted in FIGS. 5-8 (including FIGS. 5A and 8A), intravascular stent 16 and expandable membrane 5 are implanted in the patient's vascular system. Typically, in these situations there will usually be a guidewire 26 (or other guiding member) which extends across the damaged section of the artery such as shown in FIG. 6. The proximal end of guidewire 26, which extends out of the patient during the entire procedure is inserted through the distal port 20 in the distal end of catheter 12 and advanced proximally through first inner lumen 22 until the proximal end of the guidewire impacts the ramp 25 and is thereby directed through the proximal port 21.

[0031] The intravascuiar catheter 12 is preferably positioned within outer lumen 11 of the delivery sheath 10 so that at least a significant portion of the proximal port 18 in the sheath is in alignment with the proximal port 21 of the intravascular catheter. In this manner, proximal advancement of the guidewire 26 through the inner lumen 22 will also direct the proximal end of the guidewire out the proximal port 18 in the delivery sheath. The proximal end of the guidewire 26 may then be manually held to maintain the position of the guidewire within the patient's vasculature, while the stent delivery system is advanced over the guidewire and through the patient's vascular system. The advancement of the stent delivery system with expandable membrane 5 mounted thereon continues until the distal ends of the catheter and sheath extend adjacent to or across the injured or diseased area. Next, the manipulator 15 on the proximal end of the delivery system is actuated to move sheath 10 proximally with respect to the catheter 12 and thereby expose stent 16 and expandable member 5 which are mounted on balloon 14. Thereafter, inflation fluid is directed under substantial pressure through inflation lumen 27 in the catheter body 13 to the interior of balloon 14, thereby expanding the balloon and simultaneously expanding stent 16 and expandable member 5 against the vessel wall as shown in FIG. 7. After balloon 14 is deflated, the delivery systems, both sheath 10 and catheter 12, are then removed from the patient along with guidewire 26, leaving the expanded stent 16 pressing against expandable member 5 which is in contact with the vessel wall as is shown in FIGS. 8 and 8A.

[0032] The therapeutic drug contained within expand-

able membrane 5 can then diffuse directly into the vessel wall at the area of the injured or diseased vessel to provide treatment.

[0033] In another embodiment of the invention, as depicted in FIG. 4A, an over-the-wire catheter system is employed to carry the stent 16 and expandable membrane 5 within the patient's vasculature to the damaged area. A guidewire 26 is employed to cross a damaged area and locate the position within the patient so that the intravascular catheter can reach the diseased or injured area. As is typical in over-the-wire catheter systems, the intravascular catheter has an outer member 77 and an inner member 78 which are coaxially aligned. Inner member 78 has an inner lumen 79 which carries guidewire 26. The guidewire can move freely within inner lumen 79 in an axial direction. The intravascular catheter is slidably disposed within sheath 10 in inner lumen 11. Port 17 at the distal end of sheath 10 provides an opening for the catheter to extend from.

[0034] The method of deploying expandable membrane 5 is similar to that described for the rapid exchange system described above and as depicted in FIGS. 3, 5-8, and 5A and 8A. Generally, guidewire 26 is positioned at a location just past the injured or diseased area and the catheter system is threaded over guidewire 26 so that balloon 14, along with stent 16 and expandable membrane 5 are positioned at the injured or diseased area. Thereafter, balloon 14 is expanded radially outwardly to thereby expand stent 16 and expandable membrane 5. Expandable membrane 5 is sandwiched between the patient's vasculature and stent 16. Balloon 14 is then deflated and the catheter system is withdrawn from the patient's vasculature leaving stent 16 and expandable membrane 5 securely implanted in the injured or diseased area. The therapeutic drugs within expandable membrane 5 then diffuse into the patient's vessel wall to treat the injured or diseased area.

[0035] Expandable membrane 5 also can be delivered intraluminally by loading it onto a perfusion-type dilatation catheter of the type disclosed in U.S. Patent No. 5,195,971 (Sirhan) and as depicted in FIG. 4B. One advantage in using a perfusion catheter is that blood continues to flow on both sides of the inflated balloon thereby allowing longer balloon inflation times. Thus, as shown in FIG. 4B, expandable membrane 5 may be loaded directly onto balloon 41 or onto a stent carried by the balloon. Balloon 41 is mounted on tubular extension 40 which is carried by the perfusion catheter. The proximal end of balloon 41 is attached to distal section 42. The perfusion catheter has an inflation lumen 43 and a guidewire lumen 44. Inflation lumen 43 will carry inflation fluid to expand balloon 41 and expandable membrane 5. Guidewire lumen 44 will receive a guidewire (not shown) similar to that depicted in FIG. 4A. In order to permit blood to flow continuously while balloon 41 is expanded, a plurality of perfusion ports are incorporated. Thus, proximal perfusion ports 46 and distal perfusion ports 47 permit blood to flow through guidewire lumen 44 while balloon 41 and expandable membrane 5 are in their expanded condition. Intraluminal delivery and implanting are similar to that described for the over-the-wire catheter of FIG. 4A. By using a perfusion-type catheter system, expandable membrane 5 does not have to be implanted because it can be delivered and expanded into contact with the vessel wall for long periods of time without adverse effects to the patient. When the drug has diffused, the perfusion balloon is deflated and elastic membrane 5 elastically contracts along with the deflated balloon. The entire catheter system and elastic membrane 5 are then removed from the patient.

[0036] In an embodiment of the invention, as depicted in FIGS. 9 and 10, expandable membrane 5 has a first layer 80 and second layer 81 spaced apart. First layer 80 and second layer 81 are then joined along their edges to form a fluid-tight seal 82 along all of their edges. Both first layer 80 and second layer 81 can be formed from any of the expandable and elastic materials described above with respect to the elastic membrane depicted in FIG. 1.

[0037] Before joining first layer 80 to second layer 81, a plurality of apertures 84 (holes) are formed in first layer 80 by known methods, such as using a laser or other methods for making micro-holes in an elastic membrane. Holes 84 are formed in a first layer 80 while it is in stretched condition so that when first layer 80 is in a relaxed condition the holes will close to form a fluid-tight seal.

[0038] Once first layer 80 and second layer 81 have been joined together, they are stretched and a therapeutic drug is injected through any of holes 84 to fill cavity 83 which is formed between the two joined layers. After the therapeutic drug is injected into cavity 83, the expandable membrane is relaxed and holes 84 will then close so that the therapeutic drug is contained within. Expandable membrane 5 as depicted in FIG. 11 is now ready for rolling into a cylindrical configuration. It also may be desirable to roll the membrane so that the edges abut rather than overlap so that the cylindrical shape has a lower profile.

[0039] Delivery of the expandable membrane 5 of FIG. 11 is similar to that described for the expandable membrane of FIGS. 1, 2A and 2B. Again referring to the expandable membrane of FIG. 11, it can be mounted on a stent which is mounted on the balloon portion of the catheter. Thereafter, the catheter, along with the expandable membrane and stent, is delivered intraluminally as described above. Unlike the prior description relating to the expandable membrane of FIGS. 2A and 2B, expanding the expandable membrane 5 of FIG. 11 will force the therapeutic drug through holes 84 when the expandable membrane is expanded by balloon 14 and stent 16 on which it is mounted. Thus, as expandable membrane 5 gets larger, holes 84 begin to open allowing the diffusion of the therapeutic drug into the patient's vessel wall. As the balloon expands stent 16 ex-

pands radially outwardly and it increases the pressure on expandable membrane 5 and causes yet more of the therapeutic drug to diffuse outwardly into the patient's vessel wall. Expandable membrane 5 is then sandwiched between the vessel wall and stent 16 when balloon 14 is fully expanded and the stent is implanted against the vessel wall. Thus, the therapeutic drug is injected at the injured or diseased area to provide maximum treatment at the specific site. The invention eliminates systemic levels of drugs which may well result in negative (undesirable) side effects such as bleeding complications and toxicity. The polymer sleeve may also be loaded with a therapeutic drug in the form of a matrix. By loading the drug into matrix form, the time during which the drug diffuses into the vessel wall can be controlled to allow for various stages of disease treatment and recovery. Further, multiple drugs in the matrix can be diffused at rates that coordinate with the particular injury or disease to provide optimal treatment. The matrix can be dispersed in expandable membrane 5 by known methods including solvent casting, coating absorption or melt processing.

[0040] In another embodiment of the invention, as depicted in FIG. 11A, a pair of seamless cylindrical tubes, concentrically aligned, form expandable membrane 5. An inner tubular member 100 is surrounded by an outer tubular member 101 and the ends 102,103 are sealed by any known method such as welding or by adhesives. A reservoir 104 is formed between inner and outer tubular members 100,101 for receiving a therapeutic drug. A plurality of micro-holes 105 are formed in outer tubular member 101 by a laser or other known method. While expandable membrane 5 is in a stretched condition, the therapeutic drug is injected into reservoir 104 through micro-holes 105, and thereafter expandable membrane 5 is relaxed thereby closing micro-holes 105 and trapping the therapeutic drug in reservoir 104. The expandable membrane 5 of FIG. 11A can then be loaded onto a stent 16 and implanted against a vessel wall in the same manner as previously described for FIG. 11. Once expandable membrane 5 is expanded, the therapeutic drug is injected through micro-holes 105 directly into the vessel wall.

[0041] It should be understood that with all of the embodiments described herein, expandable membrane 5 can also carry one or more therapeutic drugs in a matrix format. For example, again referring to FIG. 11A, inner and outer tubular members 100,101 each may be loaded with one or more therapeutic drugs in a matrix form. when expandable membrane 5 is implanted as described above, the therapeutic drug(s) contained in the matrix will release into the vessel wall at a predetermined rate. The therapeutic drug in reservoir 104, however, will be injected into the vessel wall rapidly as previously described. Thus, by providing a combination of drugs within reservoir 104 and in matrix form in inner and outer tubular members 100,101, drugs are continuously administered at a specific site over a long period of time. For example, inner tubular member 100 can be loaded with a sustained released antithrombotic drug since the inner tubular member is in direct contact with blood flow. The outer tubular member 101, which is pressed against the vessel wall, is loaded with a sustained release antiproliferative drug. Depending on the drug and the polymer used, in excess of 40% by weight of a drug can be loaded into the tubular members 100,101.

[0042] Membrane 5 as described herein can also be made from bioabsorbable materials which will completely absorb into the patient's vascular system over time. Membrane 5 can be made from members or comembers of the linear aliphatic polyester family, polyurethanes, and composites.

[0043] The dimensions of the intravascular catheter described herein will generally follow the dimensions of intravascular catheters used in angioplasty procedures in the same arterial location. Typically, the length of a catheter for use in the coronary arteries is about 150 cm, the outer diameter of the catheter shaft is about 0.89mm (0.035 inch), the length of the balloon is typically about 2 cm, and the inflated diameter is approximately 1 to about 8 mm.

[0044] The materials of construction may be selected from those used in conventional balloon angioplasty catheters.

[0045] The delivery sheath will generally be slightly shorter than the intravascular catheter, e.g., by about the length of the manipulating device 15, with an inner diameter large enough to accommodate the intravascular catheter and to allow the catheter free longitudinal movement therein. The sheath and the catheter shaft can be made of conventional polyethylene tubing, or any other material.

[0046] While the present invention has been described herein in terms of delivering an expandable membrane and intravascular stent to a desired location within a patient's vascular system the delivery system can be employed to deliver expandable membranes and/or stents to locations within other body lumens such as peripheral arteries and vessels, the urethra, or fallopian tubes, so that the stents can be expanded to maintain the patency of these body lumens. Other areas for implanting an expandable membrane could be iliac arteries, the aorta, or virtually any other body lumen.

Claims

1. An expandable sheath for delivering a therapeutic drug in a body lumen, comprising:

    an expandable membrane (5) in the form of a cylindrical member and having a first end (1) and a second end (2), and a first layer (80) and a second layer (81), said first layer (80) and said second layer (81) being affixed to each

other along their edges to form a drug-containing reservoir (83) between the two layers (80,81), said first layer (80) having a plurality of apertures (84) through which a therapeutic drug can diffuse from within said drug-containing reservoir (83), said plurality of apertures (84) remaining open when said first layer (80) is in a stretched condition and said apertures (84) tightly closing when said first layer (80) is in a relaxed condition;
a therapeutic drug contained within said reservoir (83); and
means for intraluminally delivering and expanding said expandable membrane (5) in the body lumen so that said therapeutic drug can be eluted at a specific site in the body lumen.

2. The expandable sheath of claim 1, wherein said expandable membrane (5) is made from materials taken from the group of materials consisting of the linear aliphatic polyester family, polyurethanes, latexes, urethanes, polysiloxanes, ethylene vinyl acetate and modified styrene-ethylene/butylene-styrene block copolymers (SEBS).

3. The expandable sheath of claim 1, wherein in addition a therapeutic drug is combined with said expandable membrane (5) in a matrix by any process taken from the group of processes consisting of solvent casting, coating, melt processing or absorption.

4. The expandable sheath of claim 1, wherein said means for intraluminally delivering said expandable membrane (5) is a catheter system having a proximal end and a distal end, the catheter further having a balloon portion (14) at said distal end with said expandable membrane (5) affixed to said balloon portion (14).

5. The expandable sheath of claim 4, wherein said catheter system includes a perfusion balloon (41) to permit fluids to flow on both sides of said perfusion balloon (41) when said perfusion balloon (41) is fully expanded.

6. The expandable sheath of claim 1, wherein said means for intraluminally delivering said expandable membrane (5) is a catheter (12) having a proximal end and a distal end, the catheter further having a balloon portion (14) at said distal end, an intravascular stent (16) is mounted on said balloon portion (14), and said expandable membrane (5) is attached to said stent (16) to form a cylinder around said stent (16).

7. The expandable sheath of claim 1, wherein said cylindrical member is seamless.

8. The expandable sheath of claim 1, wherein said apertures (84) are formed in said first layer (80) by a laser when said first layer (80) is in a stretched condition.

9. The expandable sheath of claim 8, wherein said therapeutic drug is loaded into said reservoir (83) through said apertures (84) when said membrane (5) is in said stretched condition.

10. The expandable sheath of claim 9, wherein said expandable membrane (5) retains said therapeutic drug within said reservoir (83) when said membrane (5) is in a relaxed condition.

11. The expandable sheath of claim 10, wherein said membrane (5) has a first edge (6) and a second edge (7) and is rolled into a cylinder so that said first edge and said second edge (7) overlap and are attached to each other.

12. The expandable sheath of claim 10, wherein said membrane (5) has a first edge (6) and a second edge (7) and is rolled into a cylinder so that said first edge (6) and said second edge (7) abut and are attached to each other.

13. The expandable sheath of claim 11, wherein said expandable membrane (5) is attached to a balloon portion (14) of a catheter (12) for intravascular transport and delivery to a specific site in the body lumen.

14. The expandable sheath of claim 1, wherein said balloon portion (14) of said catheter (12) expands, thereby expanding said expandable membrane (5) and forcing said therapeutic drug in said reservoir (83) to diffuse through said apertures (84) and into the lumen wall.

15. The expandable sheath of claim 1, wherein said expandable membrane (5) is bioabsorbable.

16. The expandable sheath of claim 1, wherein said therapeutic drug is taken from the group consisting of antiplatelets, antithrombins and antiproliferatives.

17. The expandable sheath of claim 1, further comprising a catheter (12) having a proximal end and a distal end, the catheter further having an expandable balloon portion (14) at its distal end and an intravascular stent (16) mounted thereon, said expandable membrane (5) being affixed to said stent (16) by rolling said expandable membrane (5) to form a cylinder around said intravascular stent (16).

18. The expandable sheath of claim 17, wherein said

expandable balloon (14) is expanded from a first diameter to a second enlarged diameter thereby expanding said stent (16) and said expandable membrane (5) so that said stent (16) and said expandable membrane (5) are implanted in the body lumen.

19. The expandable sheath of claim 18, wherein said plurality of apertures (84) on said first layer (80) open when said expandable membrane (5) is expanded by said expandable balloon (14) and intravascular stent (16), so that as said plurality of apertures (84) open the therapeutic drug will diffuse from within said drug-containing reservoir (83) to said body lumen.

20. The expandable sheath of claim 1, wherein said first layer (80) has an outer surface loaded with a sustained release therapeutic drug so that when said outer surface contacts the body lumen said drug will diffuse into the body lumen at a predetermined rate.

21. The expandable sheath of claim 20, wherein said sustained release therapeutic drug is an antiproliferative drug.

22. The expandable sheath of claim 1, wherein said second layer (81) has an inner surface in contact with blood flow, said inner surface being loaded with a sustained release antithrombotic drug for diffusing into the blood at a predetermined rate.

23. The expandable sheath of claim 4, further comprising: means for loading said expandable membrane (5) on said balloon portion (14) on said catheter system so that when said balloon portion (14) is inflated said balloon portion (14) will expand radially outwardly thereby expanding said expandable membrane (5) into contact with said body lumen so that said therapeutic drug can be eluted at a specific site in the body lumen.

24. The expandable sheath of claim 23, wherein said balloon portion (14) of said catheter is a perfusion balloon (41) permitting blood flow on either side of said perfusion balloon (41) when said perfusion balloon (41) is fully expanded.

25. The expandable sheath of claim 23, wherein said expandable membrane (5) has a low modulus of elasticity and can expand to at least 300% of its initial size.

Patentansprüche

1. Aufweitbare Hülle zum Verabreichen eines therapeutischen Medikaments in ein Körperlumen, umfassend:

eine aufweitbare Membrane (5) in der Form eines zylindrischen Elements, und die ein erstes Ende (1) und ein zweites Ende (2) sowie eine erste Schicht (80) und eine zweite Schicht (81) aufweist, wobei die erste Schicht (80) und die zweite Schicht (81) entlang ihrer Ränder aneinander befestigt sind, um zwischen den zwei Schichten (80, 81) ein Medikamenten-Aufnahmereservoir (83) zu bilden, wobei die erste Schicht (80) eine Mehrzahl von Öffnungen (84) aufweist, durch die ein therapeutisches Medikament von innerhalb des Medikamenten-Aufnahmereservoirs (83) diffundieren kann, wobei die Mehrzahl der Öffnungen (84) offen bleiben, wenn die erste Schicht (80) in einem gestreckten Zustand ist, und die Öffnungen (84) dicht verschließen, wenn die erste Schicht (80) in einem entspannten Zustand ist;
ein in dem Reservoir (83) enthaltenes therapeutisches Medikament; und
Mittel zum intraluminalen Abgeben und Aufweiten der aufweitbaren Membrane (5) in dem Körperlumen, so dass das therapeutische Medikament an einer spezifischen Stelle in dem Körperlumen eluiert werden kann.

2. Aufweitbare Hülle nach Anspruch 1, worin die aufweitbare Membrane (5) aus Materialien hergestellt ist, die aus der Gruppe von Materialien genommen sind, die aus der lineare aliphatische Polyester-Familie, Polyurethanen, Latizes, Urethanen, Polysiloxanen, Ethylenvinylacetat und modifizierten Styrol-Ethylen/Butylen-Styrol-Block-Copolymeren (SEBS) besteht.

3. Aufweitbare Hülle nach Anspruch 1, worin zusätzlich ein therapeutisches Medikament mit der aufweitbaren Membrane (5) in einer Matrix durch einen Prozess kombiniert ist, der aus der Gruppe von Prozessen genommen ist, die aus Lösungsmittelguss, Beschichtung, Schmelzverarbeitung oder Absorption besteht.

4. Aufweitbare Hülle nach Anspruch 1, worin das Mittel zum intraluminalen Einführen der aufweitbaren Membrane (5) ein Kathetersystem ist, das ein proximales Ende und ein distales Ende aufweist, wobei der Katheter an dem distalen Ende ferner einen Ballonabschnitt (14) mit der an dem Ballonabschnitt (14) befestigten aufweitbaren Membrane (5) aufweist.

5. Aufweitbare Hülle nach Anspruch 4, worin das Kathetersystem einen Perfusionsballon (41) enthält, um zu gestatten, dass Fluide an beiden Seiten des Perfusionsballons (41) fließen, wenn der Perfusionsballon (41) vollständig aufgeweitet ist.

6. Aufweitbare Hülle nach Anspruch 1, worin das Mittel zum intraluminalen Einführen der aufweitbaren Membrane (5) ein Katheter (12) ist, der ein proximales Ende und ein distales Ende ist, wobei der Katheter ferner einen Ballonabschnitt (14) an dem distalen Ende aufweist, ein intravaskularer Stent (16) an dem Ballonabschnitt (14) montiert ist und die aufweitbare Membrane (5) an dem Stent (16) angebracht ist, um um den Stent (16) herum einen Zylinder zu bilden.

7. Aufweitbare Hülle nach Anspruch 1, worin das zylindrische Element nahtlos ist.

8. Aufweitbare Hülle nach Anspruch 1, worin die Öffnungen (84) in der ersten Schicht (80) durch einen Laser gebildet sind, wenn die erste Schicht (80) in einem gestreckten Zustand ist.

9. Aufweitbare Hülle nach Anspruch 8, worin das therapeutische Medikament durch die Öffnungen (84) in das Reservoir (83) geladen wird, wenn die Membrane (5) in dem gestreckten Zustand ist.

10. Aufweitbare Hülle nach Anspruch 9, worin die aufweitbare Membrane (5) das therapeutische Medikament in dem Reservoir (83) zurückhält, wenn die Membrane (5) in einem entspannten Zustand ist.

11. Aufweitbare Hülle nach Anspruch 10, worin die Membrane (5) einen ersten Rand (6) und einen zweiten Rand (7) aufweist und zu einem Zylinder gerollt ist, so dass der erste Rand und der zweite Rand (7) überlappen und aneinander angebracht sind.

12. Aufweitbare Hülle nach Anspruch 10, worin die Membrane (5) einen ersten Rand (6) und einen zweiten Rand (71) aufweist und zu einem Zylinder gerollt ist, so dass der erste Rand (6) und der zweite Rand (7) stumpf aneinander stoßen und aneinander angebracht sind.

13. Aufweitbare Hülle nach Anspruch 11, worin die aufweitbare Membrane (5) an einem Ballonabschnitt (14) eines Katheters (12) zum intravaskularen Transport und Einfuhr zu einer spezifischen Stelle in dem Körperlumen angebracht ist.

14. Aufweitbare Hülle nach Anspruch 13, worin der Ballonabschnitt (14) des Katheters (12) aufweitet, um hierdurch die aufweitbare Membrane (5) aufzuweiten und das therapeutische Medikament in dem Reservoir (83) zu zwingen, durch die Öffnungen (84) und in die Lumenwand zu diffundieren.

15. Aufweitbare Hülle nach Anspruch 1, worin die aufweitbare Membrane (5) bioabsorbierbar ist.

16. Aufweitbare Hülle nach Anspruch 1, worin das therapeutische Medikament aus der Gruppe genommen ist, die aus Antiplatelets, Antithrombinen und Antiproliferativen besteht.

17. Aufweitbare Hülle nach Anspruch 1, die ferner einen Katheter (12) mit einem proximalen Ende und einem distalen Ende aufweist, wobei der Katheter ferner an seinem distalen Ende einen aufweitbaren Ballonabschnitt (14) und einen daran angebrachten intravaskularen Stent (16) aufweist, wobei die aufweitbare Membrane (5) an dem Stent (16) befestigt ist, indem die aufweitbare Membrane (5) zur Bildung eines Zylinders um den intravaskularen Stent (16) herum gerollt ist.

18. Aufweitbare Hülle nach Anspruch 17, worin der aufweitbare Ballon (14) von einem ersten Durchmesser zu einem zweiten vergrößerten Durchmesser aufgeweitet wird, um hierdurch den Stent (16) und die aufweitbare Membrane (5) aufzuweiten, so dass der Stent (16) und die aufweitbare Membrane (5) in dem Körperlumen implantiert werden.

19. Aufweitbare Hülle nach Anspruch 18, worin die Mehrzahl von Öffnungen (84) an der ersten Schicht (80) öffnen, wenn die aufweitbare Membrane (5) durch den aufweitbaren Ballon (14) und den intravaskularen Stent (16) aufgeweitet wird, so dass dann, wenn die Mehrzahl von Öffnungen (84) öffnen, das therapeutische Medikament von dem Medikamenten-Aufnahmereservoir (83) zu dem Körperlumen diffundiert.

20. Aufweitbare Hülle nach Anspruch 1, worin die erste Schicht (80) eine Außenoberfläche aufweist, die mit einem therapeutischen Dauerfreigabe-Medikament beladen ist, so dass dann, wenn die Außenfläche das Körperlumen berührt, das Medikament mit einer vorbestimmten Rate in das Körperlumen diffundiert.

21. Aufweitbare Hülle nach Anspruch 20, worin das therapeutische Dauerfreigabe-Medikament ein antiproliferatives Medikament ist.

22. Aufweitbare Hülle nach Anspruch 1, worin die zweite Schicht (81) eine mit dem Blutfluss in Kontakt stehende Innenoberfläche aufweist, wobei die Innenoberfläche mit einem antithrombotischen Dauerfreigabe-Medikament beladen ist, um mit einer vorbestimmten Rate in das Blut zu diffundieren.

23. Aufweitbare Hülle nach Anspruch 4, die ferner umfasst: Mittel zum Laden der aufweitbaren Membrane (5) auf den Ballonabschnitt (14) an dem Kathetersystem, so dass dann, wenn der Ballonabschnitt (14) aufgepumpt wird, sich der Ballonabschnitt (14)

radial auswärts aufweitet, um hierdurch die aufweitbare Membrane (5) in Kontakt mit dem Körperlumen aufzuweiten, so dass das therapeutische Medikament mit einer spezifischen Rate in das Körperlumen eluiert werden kann.

24. Aufweitbare Hülle nach Anspruch 23, worin der Ballonabschnitt (14) des Katheters ein Perfusionsballon (41) ist, der einen Blutfluss von jeder Seite des Perfusionsballons (41) gestattet, wenn der Perfusionsballon (41) vollständig aufgeweitet ist.

25. Aufweitbare Hülle nach Anspruch 23, worin die aufweitbare Membrane (5) ein niedriges Elastizitätsmodul hat und auf zumindest 300% seiner ursprünglichen Größe aufgeweitet werden kann.

Revendications

1. Manchon dilatable, destiné à fournir un médicament dans un passage anatomique du corps, et comprenant :

une membrane dilatable (5) sous la forme d'un élément cylindrique et présentant une première extrémité (1) et une deuxième extrémité (2), et une première couche (80) ainsi qu'une deuxième couche (81), ladite première couche (80) et ladite deuxième couche (81) étant attachées l'une à l'autre le long de leurs bords afin de former un réservoir de médicament (83) entre les deux couches (80, 81), ladite première couche (80) comportant une pluralité d'orifices (84) par l'intermédiaire desquels un médicament peut se diffuser à partir de l'intérieur dudit réservoir de médicament (83), ladite pluralité d'orifices (84) demeurant ouverts lorsque ladite première couche (80) est à l'état tendu et lesdits orifices (84) se refermant de façon étanche lorsque ladite première couche (80) est à l'état détendu ; un médicament, contenu dans ledit réservoir (83) ; et

un moyen servant à la mise en place, à l'intérieur du passage anatomique, et à la dilatation de ladite membrane dilatable (5) dans le passage anatomique du corps, de telle sorte que ledit médicament puisse être libéré en un emplacement spécifique dans le passage anatomique du corps.

2. Manchon dilatable selon la revendication 1, dans lequel ladite membrane dilatable (5) est faite à partir de matériaux, sélectionnés à partir du groupe de matériaux se composant de la famille des polyesters aliphatiques linéaires, des polyuréthanes, des latex, des uréthanes, des polysiloxanes, de l'éthylène-acétate de vinyle et des copolymères séquencés modifiés styrène-éthylène/butylène-styrène (SEBS).

3. Manchon dilatable selon la revendication 1, dans lequel, en outre, un médicament est combiné à ladite membrane dilatable (5) dans une matrice, par un procédé quelconque sélectionné à partir du groupe de procédés comprenant la coulée avec solvant, le revêtement, le traitement par fusion ou l'absorption.

4. Manchon dilatable selon la revendication 1, dans lequel ledit moyen servant à la mise en place, à l'intérieur du passage anatomique, de ladite membrane dilatable (5), est un système de cathéter présentant une extrémité proximale et une extrémité distale, le cathéter comprenant en outre une partie formant ballon (14) située au niveau de ladite extrémité distale, et ladite membrane dilatable (5) étant attachée à ladite partie formant ballon (14).

5. Manchon dilatable selon la revendication 4, dans lequel ledit système de cathéter comprend un ballon de perfusion (41) afin de permettre à des fluides de s'écouler des deux côtés dudit ballon de perfusion (41) lorsque ledit ballon de perfusion (41) est complètement dilaté.

6. Manchon dilatable selon la revendication 1, dans lequel ledit moyen servant à la mise en place, à l'intérieur du passage anatomique, de ladite membrane dilatable (5), est un cathéter (12) présentant une extrémité proximale et une extrémité distale, le cathéter comprenant en outre une partie formant ballon (14) au niveau de ladite extrémité distale, un élargisseur intravasculaire (16) monté sur ladite partie formant ballon (14), et ladite membrane dilatable (5) étant fixée audit élargisseur (16) afin de former un cylindre autour dudit élargisseur (16).

7. Manchon dilatable selon la revendication 1, dans lequel ledit élément cylindrique est "sans soudure".

8. Manchon dilatable selon la revendication 1, dans lequel lesdits orifices (84) sont formés dans ladite première couche (80) par un laser, lorsque ladite première couche (80) est à l'état tendu.

9. Manchon dilatable selon la revendication 8, dans lequel ledit médicament est chargé dans ledit réservoir (83) par l'intermédiaire desdits orifices (84), lorsque ladite membrane (5) est dans ledit état tendu.

10. Manchon dilatable selon la revendication 9, dans lequel ladite membrane dilatable (5) retient ledit médicament à l'intérieur dudit réservoir (83), lorsque ladite membrane (5) est à l'état détendu.

11. Manchon dilatable selon la revendication 10, dans lequel ladite membrane (5) comporte un premier bord (6) et un deuxième bord (7) et est enroulée en un cylindre de telle sorte que ledit premier bord et ledit deuxième bord (7) se chevauchent et soient fixés l'un à l'autre.

12. Manchon dilatable selon la revendication 10, dans lequel ladite membrane (5) comporte un premier bord (6) et un deuxième bord (7) et est enroulée en un cylindre de telle sorte que ledit premier bord (6) et ledit deuxième bord (7) se trouvent bout à bout et soient fixés l'un à l'autre.

13. Manchon dilatable selon la revendication 11, dans lequel ladite membrane dilatable (5) est fixée à une partie formant ballon (14) d'un cathéter (12) pour un acheminement intravasculaire et pour une mise en place dans un emplacement spécifique dans le passage anatomique du corps.

14. Manchon dilatable selon la revendication 13, dans lequel ladite partie formant ballon (14) dudit cathéter (12) se dilate, pour ainsi dilater ladite membrane dilatable (5) et forcer ledit médicament, contenu dans ledit réservoir (83), à se diffuser par l'intermédiaire desdits orifices (84), vers l'intérieur de la paroi du passage anatomique.

15. Manchon dilatable selon la revendication 1, dans lequel ladite membrane dilatable (5) est bioabsorbable.

16. Manchon dilatable selon la revendication 1, dans lequel ledit médicament est sélectionné à partir du groupe comprenant des antiplaquettes, des antithrombines et des médicaments anti-prolifération.

17. Manchon dilatable selon la revendication 1, comprenant en outre un cathéter (12) présentant une extrémité proximale et une extrémité distale, le cathéter comprenant en outre une partie formant ballon dilatable (14) au niveau de son extrémité distale, et un élargisseur intravasculaire (16) monté sur cette partie, ladite membrane dilatable (5) étant attachée audit élargisseur (16) par enroulement de ladite membrane dilatable (5) afin de former un cylindre autour dudit élargisseur intravasculaire (16).

18. Manchon dilatable selon la revendication 17, dans lequel ledit ballon dilatable (14) est dilaté à partir d'un premier diamètre pour prendre un deuxième diamètre agrandi, pour ainsi dilater ledit élargisseur (16) et ladite membrane dilatable (5), de telle sorte que ledit élargisseur (16) et ladite membrane dilatable (5) soient implantés dans le passage anatomique du corps.

19. Manchon dilatable selon la revendication 18, dans lequel ladite pluralité d'orifices (84) situés dans la première couche (80) s'ouvrent lorsque ladite membrane dilatable (5) est dilatée par ledit ballon dilatable (14) et par ledit élargisseur intravasculaire (16), de telle sorte que, lorsque ladite pluralité d'orifices (84) s'ouvrent, le médicament se diffuse, à partir de l'intérieur dudit réservoir de médicament (83), vers ledit passage anatomique du corps.

20. Manchon dilatable selon la revendication 1, dans lequel ladite première couche (80) a une surface extérieure qui est chargée d'un médicament à libération continue, si bien que, lorsque ladite surface extérieure vient en contact avec le passage anatomique du corps, ledit médicament se diffuse à l'intérieur du passage anatomique du corps à une vitesse prédéterminée.

21. Manchon dilatable selon la revendication 20, dans lequel ledit médicament à libération continue est un médicament anti-prolifération.

22. Manchon dilatable selon la revendication 1, dans lequel ladite deuxième couche (81) a une surface intérieure en contact avec le flux sanguin, ladite surface intérieure étant chargée d'un médicament antithrombose à libération continue, pour une diffusion dans le sang à une vitesse prédéterminée.

23. Manchon dilatable selon la revendication 4, comprenant en outre : un moyen pour charger ladite membrane dilatable (5) sur ladite partie formant ballon (14) sur ledit système de cathéter de telle sorte que, lorsque ladite partie formant ballon (14) est gonflée, ladite partie formant ballon (14) se dilate radialement vers l'extérieur pour ainsi dilater ladite membrane dilatable (5) pour qu'elle vienne en contact avec ledit passage anatomique du corps, afin que le médicament puisse être libéré en un emplacement spécifique à l'intérieur du passage anatomique du corps.

24. Manchon dilatable selon la revendication 23, dans lequel ladite partie formant ballon (14) dudit cathéter est un ballon de perfusion (41) afin de permettre l'écoulement du sang de part et d'autre dudit ballon de perfusion (41), lorsque ledit ballon de perfusion (41) est complètement dilaté.

25. Manchon dilatable selon la revendication 23, dans lequel ladite membrane dilatable (5) a un bas module d'élasticité et peut se dilater jusqu'à au moins 300 % de sa taille initiale.

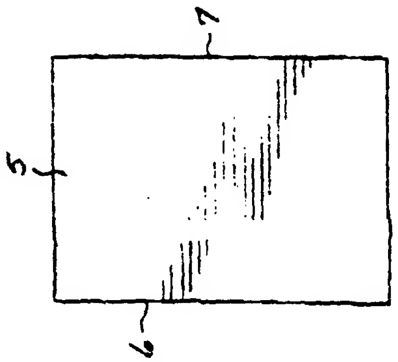


FIG.1

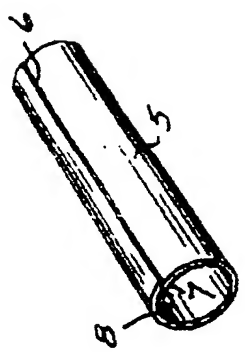


FIG.2A

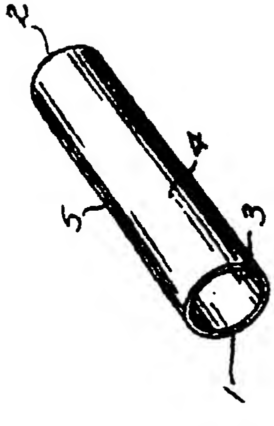


FIG.2B

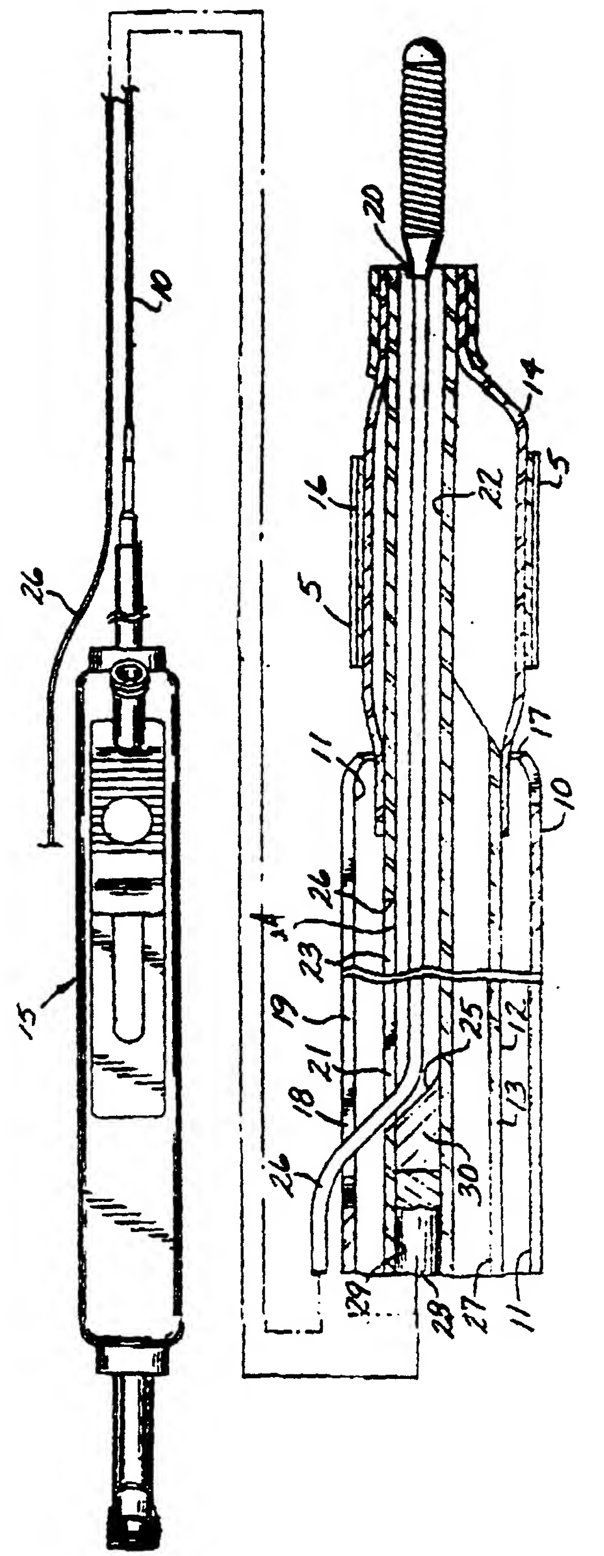


FIG.3

FIG.4A

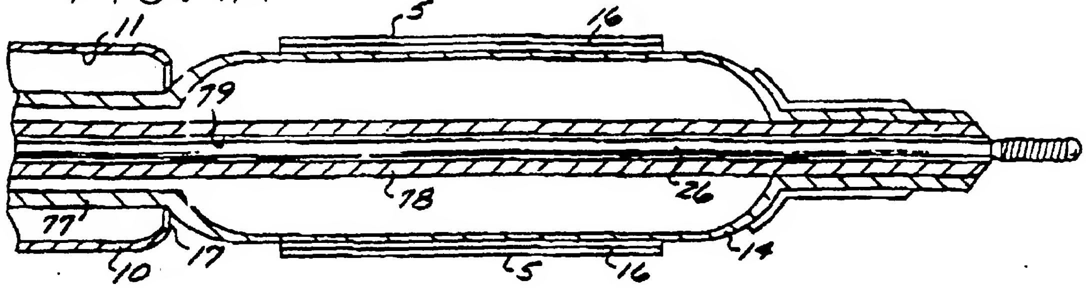


FIG.4B

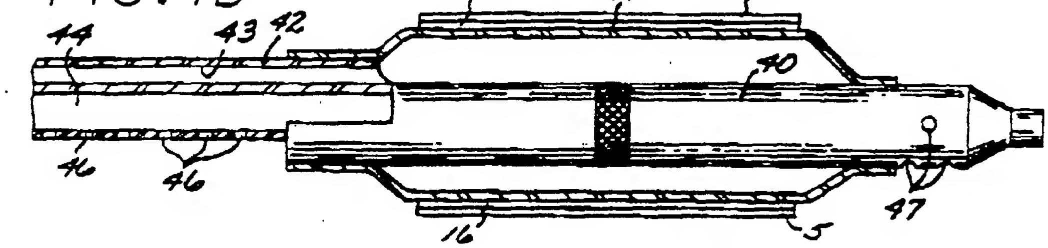
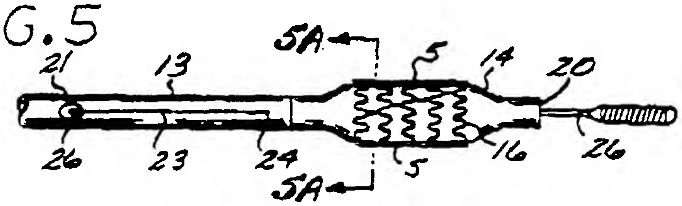


FIG.5



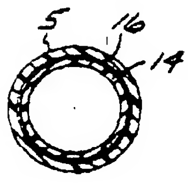


FIG.5A

FIG.6

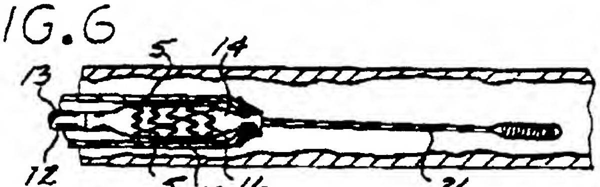
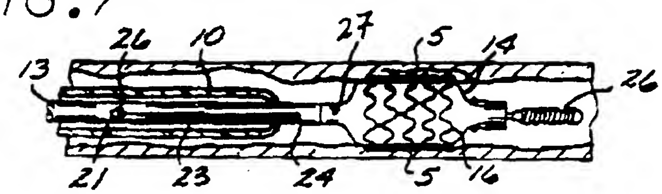


FIG.7



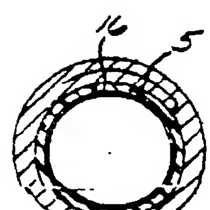


FIG.8

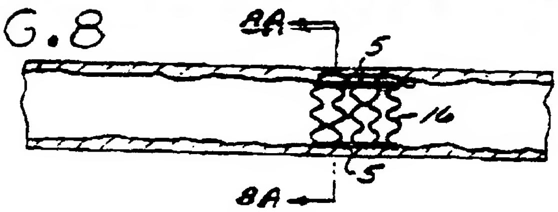


FIG.8A

FIG.9

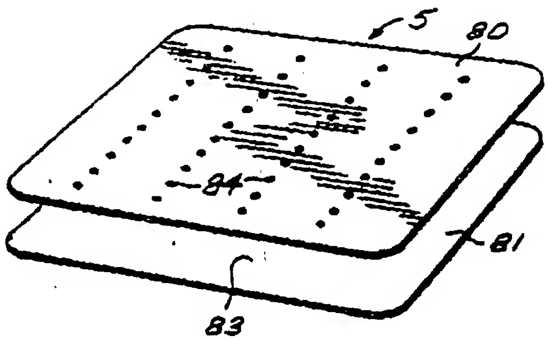


FIG.10

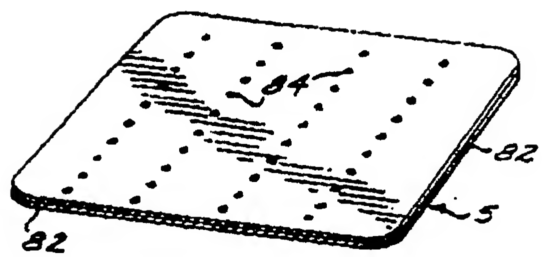


FIG.11

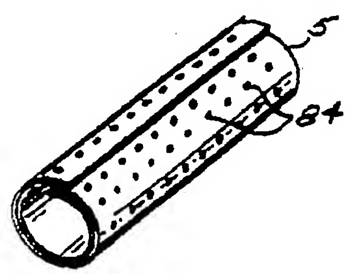


FIG.11A